

# Chapter 10 Fiber Outside Plant Design and Modeling

---

The central core fiber-optic cable network has already been constructed to the Traffic Operations Center (TOC). Typically, new projects build trunkline fiber-optic outside plant (OSP) infrastructure. There is also a possibility that additional TOC facilities, such as the Interim TOC (ITOC) in Tucson and Alternate TOC (ATOC) in Peoria, will be constructed as the overall network evolves. This new infrastructure inevitably relies on connectivity to the existing fiber-optic OSP network. New FMS devices coming online will connect to the TOC via new and existing fiber-optic cable and nodes. This situation creates many challenges for the designer and contractor. Among them are the following:

- Where future trunkline fiber is to be spliced to existing trunkline fiber, each existing spare dark fiber strand typically needs to have its source and destination verified, beginning at the TOC, through every intermediate node building, ending at the new trunkline connection. End-to-end attenuation of each fiber should be measured unidirectionally (at a minimum) using a laser light source and power meter.
- Completion of new FMS projects will require a rigorous As-Built documentation process, where Contractors must document all splice data, and construction managers are responsible for certifying that the data supplied by the Contractor is accurate prior to payment.
- Existing facilities need to be documented and dark fibers connectorized to the network.

## 10.1 OSP Model

In a perfect world, a model of the fiber-optic OSP infrastructure (i.e. origination points, cables, splice closures, hubs, nodes, and devices) would accurately depict the following:

- Geographic Information System (GIS) based model of the OSP
- Splice data at every splice point
- Capability to trace a fiber path from the origination point to every FMS device

This OSP model involves two types of data: GIS and tabular:

- GIS data is obviously needed on a basic level to track the physical location of the OSP. GIS data is key to locating OSP facilities quickly when there is a failure on the network. Tabular data is key from a design perspective to track the lengths of fiber runs to ensure that fiber losses are accounted for in the design.
- Tabular data describes every fiber strand splice or termination at each node point, i.e., termination point (TOC, node building, or FMS device) or splice closure (No. 9 pullbox), including cable foot markings etc.

## 10.1.1 Fiber Splice Tables

Table 10.1 and Figure 10.1 through Figure 10.5 depict five levels of detail used to describe the OSP model.

**Note:** *These figures are used as examples only. ADOT no longer utilizes Sonet Communication Technology.*

**Table 10.1 OSP Model Description**

LEVEL	MACRO TO MICRO	DESCRIPTION OF COVERAGE	EXAMPLE – SEE FIGURE:
1	Macro	System-wide	Fig. 11.1
2		Node-to-Node, Project	Fig 11.2
3		Freeway Segment	Fig. 11.3
4		Cable segment	Fig 11.4
5	Micro	Individual splice	Fig 11.5

Fiber-optic splice information is the foundation of the OSP database. This information is useful in different forms to different users:

- Designers and system managers typically need network information, a macro level view. They concentrate on connecting individual devices to the TOC via the overall network. Details from the macro to the micro level are necessary to design and manage the system. Figure 10.1 through Figure 10.4 illustrate the typical design progression from system, nodes, freeway segments, down to cable segments.
- Contractors and maintenance staff typically need information focused on one specific problem area, usually a splice closure or termination point, hence a micro level view. Finding a specific problem area typically involves a search of documents starting at the macro level and moving to the micro level to “zero in” on the problem. Figure 10.1 to
- Figure 10.5 illustrate this progression. Ultimately, the smallest level of interest would be a single splice closure point. An example of a single splice detail, showing the splices before and after construction, is shown in
- Figure 10.5. Designers may be required to generate this type of document in their calculation book as a submittal with other design plans. Contractors may be required to track any as-built changes to these splice details as part of their project System Acceptance Test process.

There are instances where a project will not have communication ring architecture, as illustrated in Figure 10.2.

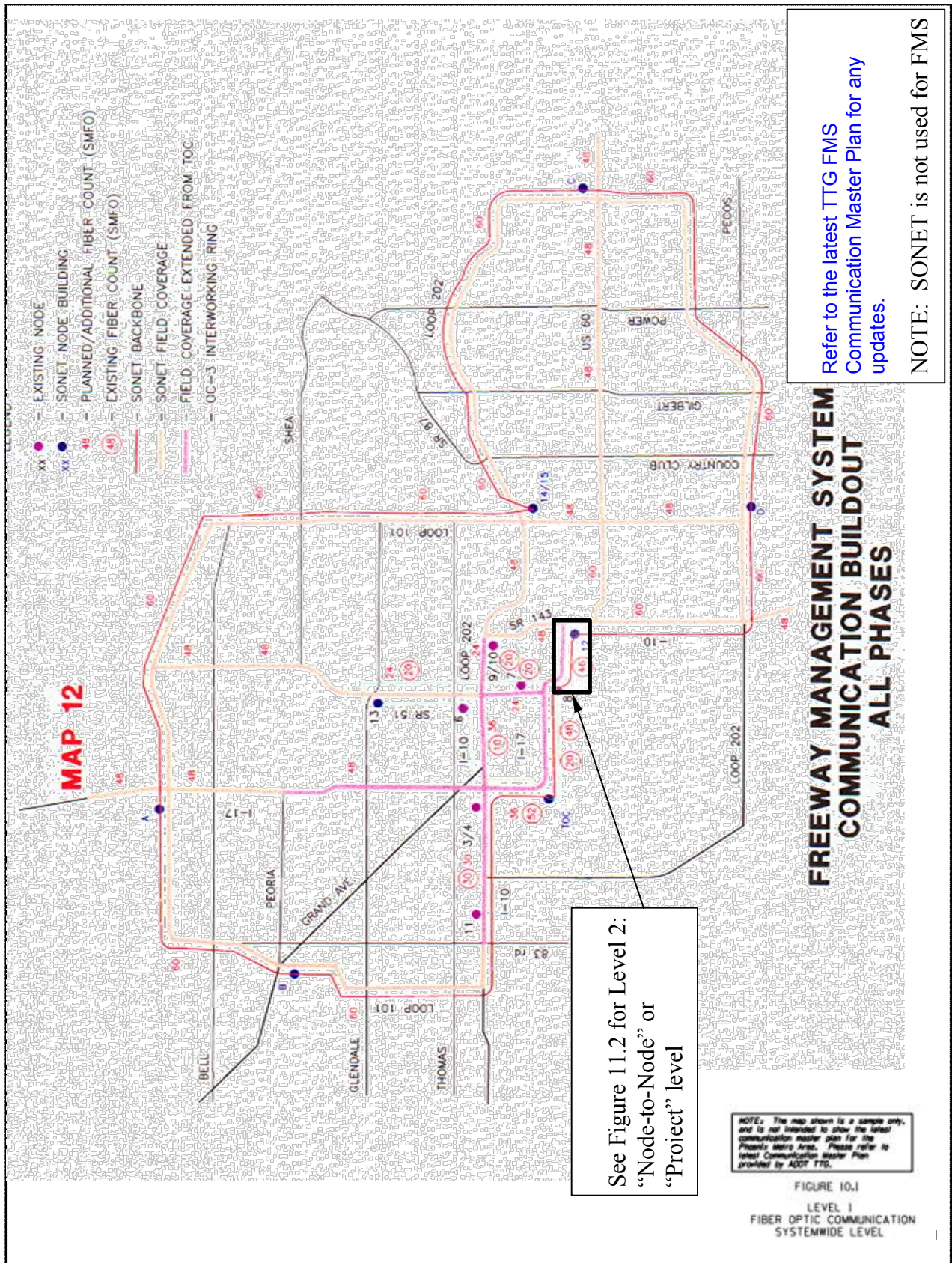


Figure 10.1 Level 1 Fiber Optic Communication System-wide Level

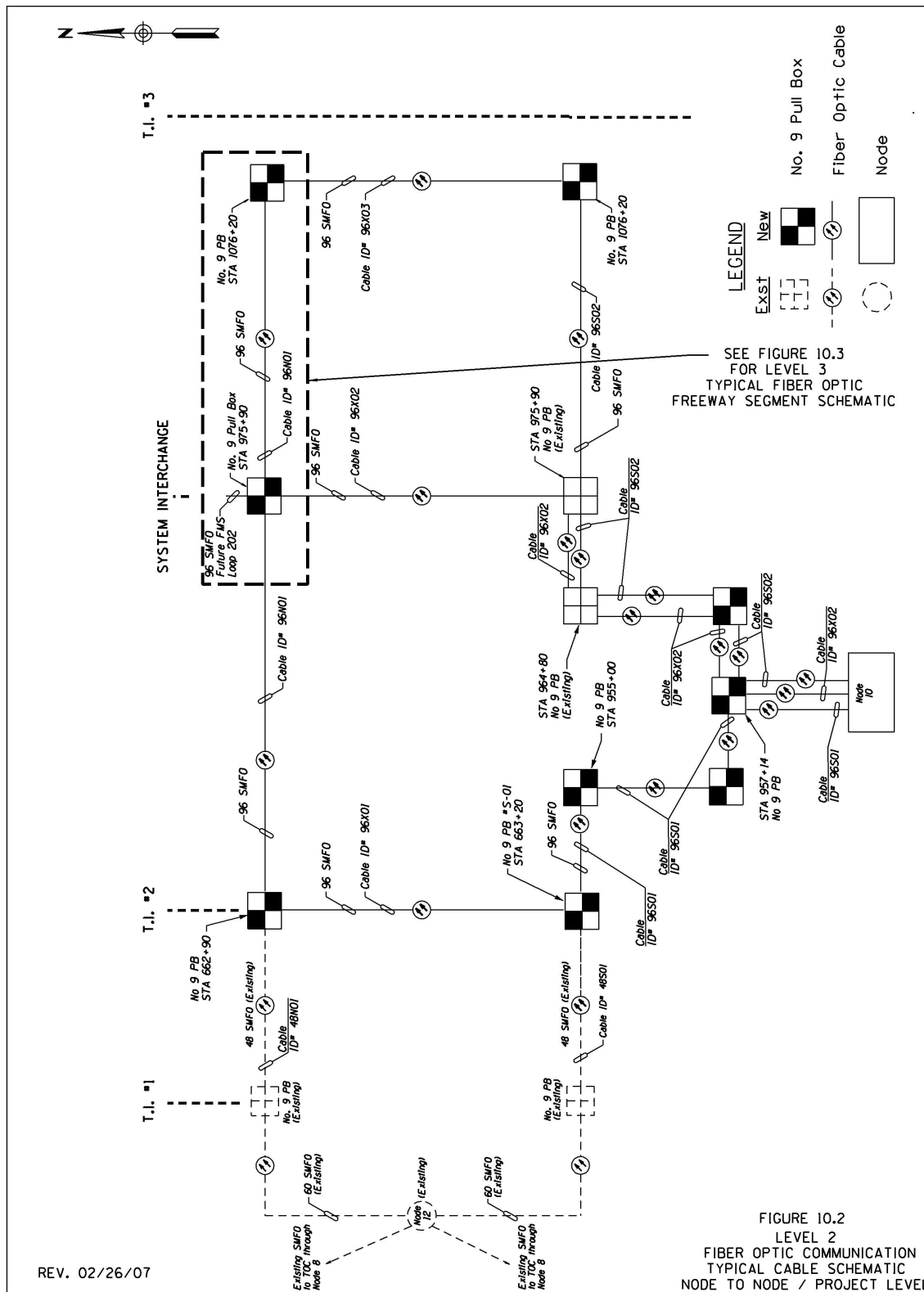


Figure 10.2 Level 2 Fiber Optic Communication Typical Cable Schematic

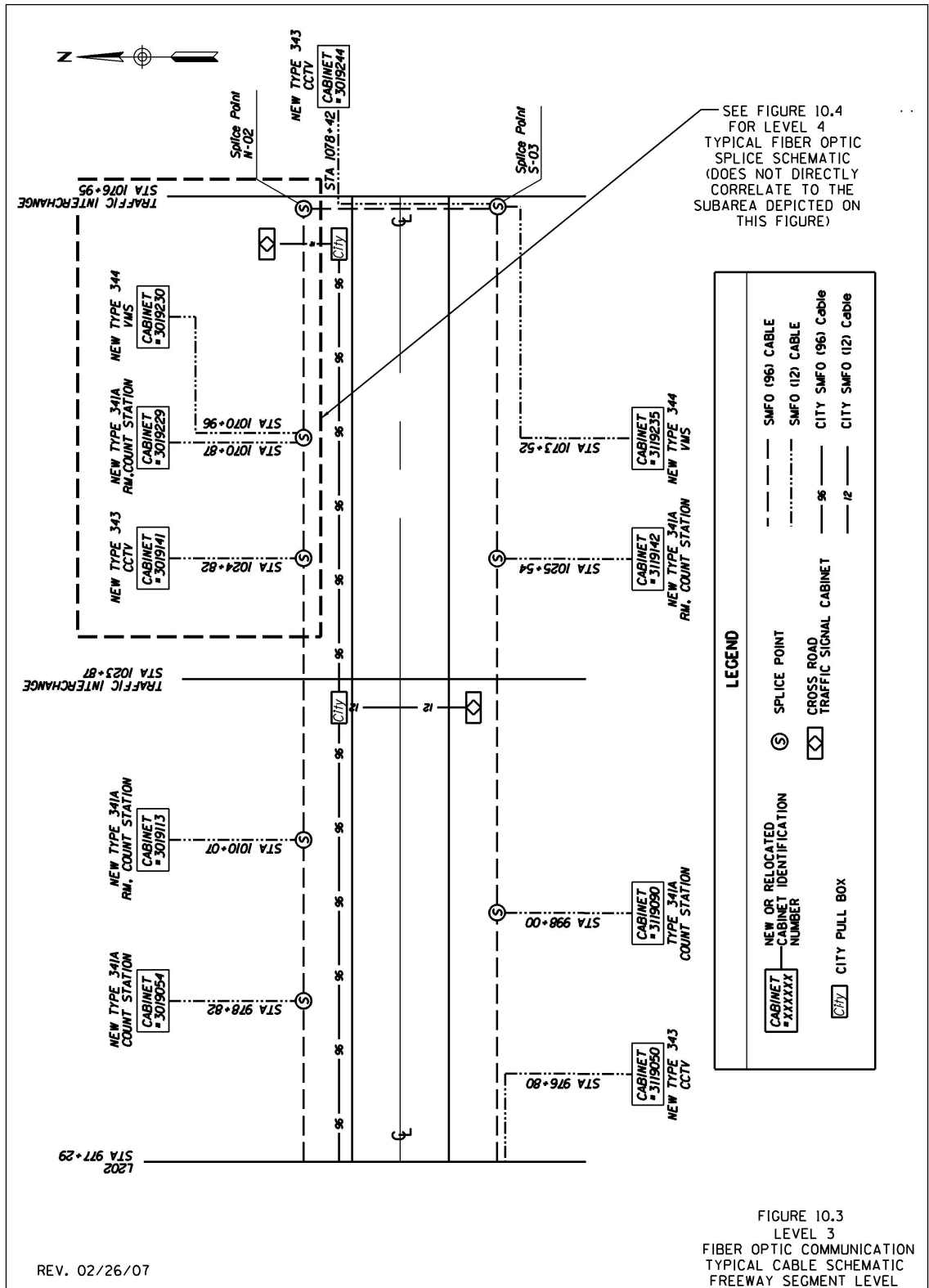


Figure 10.3 Level 3 Fiber Optic Communication Typical Cable Schematic

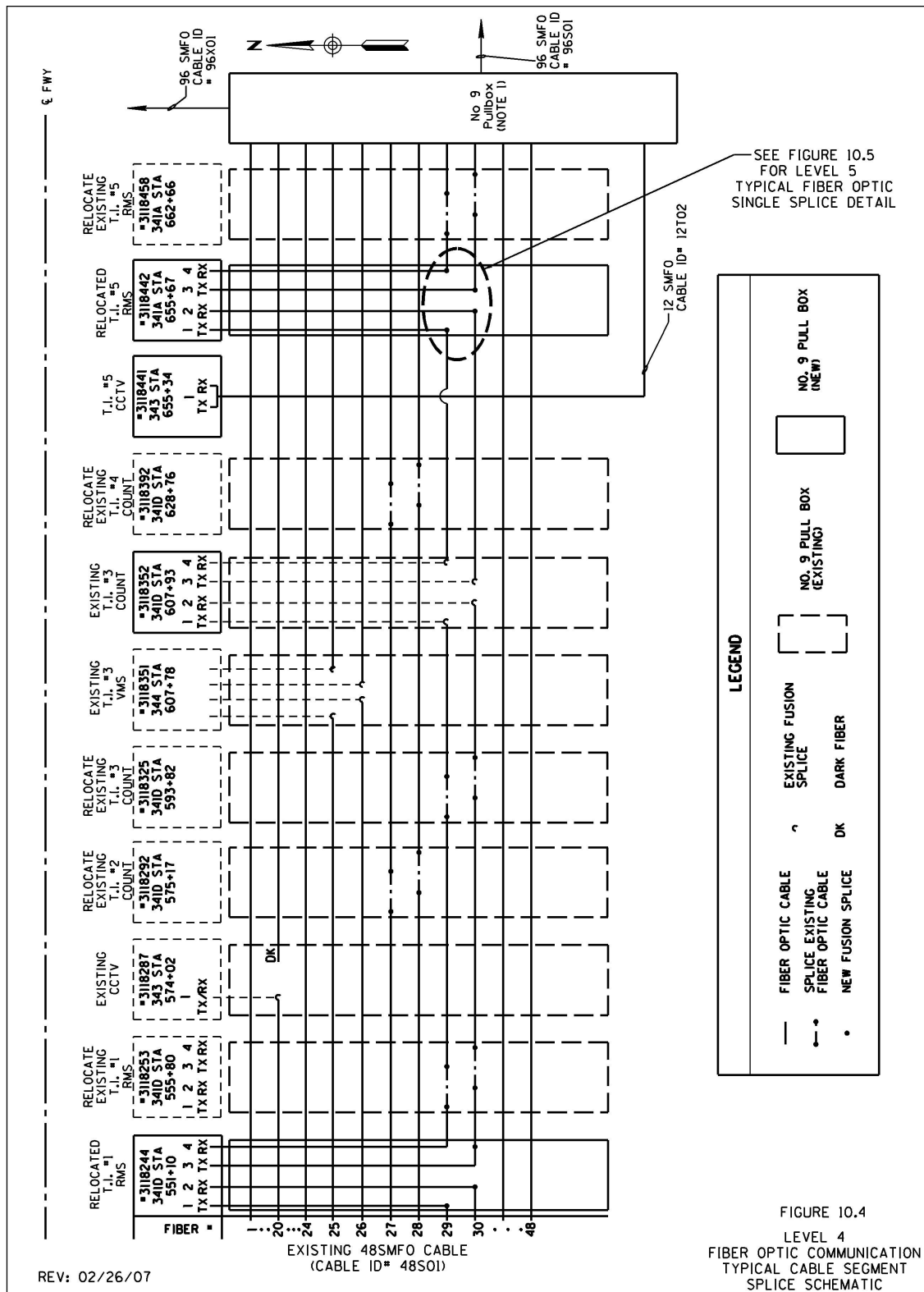


Figure 10.4 Level 4 Fiber Optic Communication Typical Cable Segment

**Typical Field Work Order for Splicing at a Single Location**

<b>CABINET 3118442</b>		
<b>SPLICE DETAILS</b>		
<b>SPLICE LOCATION STA 655+67-WB</b>		
Cable #4 Cable ID 48 SO1 From No. 9 @ 628+76	8SMFO To Cabinet 3118442	Cable #4 Cable ID 48 SO1 To No. 9 @ 662+66
Fiber	Fiber	Fiber
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
29		29
30		30

**Before Construction**

<b>CABINET 3118442</b>					
<b>SPLICE DETAILS</b>					
<b>SPLICE LOCATION STA 655+67-WB</b>					
Cable #4 Cable ID 48 SO1 From No. 9 @ 628+76		8SMFO To Cabinet 3118442	Cable #4 Cable ID 48 SO1 To No. 9 @ 662+66		
Cable Ft Marking		Cable Ft Marking	Cable Ft Marking		
In	Out	In	Out	In	Out
5300	N/A	100	183	N/A	5400
Fiber		Fiber	Fiber		
29		1			
30		2			
		3	29		
		4	30		
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			

**After Construction**

FIGURE 10.5  
LEVEL 5  
FIBER OPTIC COMMUNICATION  
SINGLE SPICE LEVEL

**Figure 10.5 Level 5 Fiber Optic Communication Single Splice Level**

## 10.2 OSP Software

Designers are familiar with *Microstation*<sup>™</sup>, the *Bentley Corp.* software used by ADOT and 41 other state departments of transportation for Computer Aided Design (CAD). Design of fiber OSP for ADOT will continue to utilize *Microstation*<sup>™</sup>, just as it does for every other aspect of FMS design, traffic design, and roadway design, etc.

ADOT has also initiated the use of software specifically for tracking OSP infrastructure called OSP Insight<sup>®</sup>. OSP Insight<sup>®</sup>, a product of Advanced Fiber-optics Inc., runs as an extension of ArcEDIT<sup>®</sup> ESRI software (OSP Insight<sup>®</sup> can also be used on other GIS mapping platforms, such as MapINFO<sup>®</sup>). ArcEDIT<sup>®</sup> operates as a relational database connected to Oracle<sup>®</sup> or other database products.

The designers should provide a Microstation<sup>™</sup> design that facilitates translation of the as-built version of the design into the OSP Insight<sup>®</sup> database.

**Table 10.2 Translating Data**

TRANSLATING DATA FROM MICROSTATION <sup>™</sup> TO OSP INSIGHT <sup>®</sup>			
<b>Fiber Infrastructure</b> ⇔		<i>Location of cables, splice closures, and termination points</i>	<i>Fiber-optic splice table</i>
<b>DESIGNER</b>	<i>Type of data</i> ⇔	<u>Geographic</u>	<u>Tabular</u>
	<i>Microstation environment</i>	Microstation (.dgn)	Microstation elements connected to relational database with “tags”.
		↓	↓
<b>ADOT</b>	<b>OSPInsight/ ArcEdit environment</b>	Shape file (4 or 5 file extensions)	Access (.mdb)/Oracle relational database file
	<b>Translation method from Microstation to OSP Insight/ArcEdit</b>	ESRI/Bentley add on modules for full interoperability for translating .dgn elements (lines, arcs, cells, etc.) to shape files with level, color, and weight control.	Tag values attached to fiber infrastructure dgn. Elements, such as fiber splice, GPS, identification, and other tabular data reside in the relational database accessible also by OSPInsight/ArcEdit

Recommendations for designers:

- Microstation CAD design files of fiber-optic cable infrastructure should be connected to the same relational database that is connected to OSP Insight. The infrastructure elements tracked in OSP Insight should be identified. Typical elements include fiber-optic cables, enclosures, pullboxes, splice closures, and termination points/devices.
- Designers must utilize tag sets that agree with the relational database elements. For example, a tag set for a splice closure could include the location description pullbox, the number for that location as it is designated in the database, e.g., “614”, the identifier for each cable connecting to the splice closure “SMFO-96”, the destination of the next splice closure on that cable “615”, status of each fiber in that cable “fiber 1: spliced / not spliced”, “fiber 2: spliced/ not spliced”.

- Defining a tag library from scratch may be avoided by importing tag definitions from the relational database to create the library.
- Designers should be required to attach tags to each element in the Microstation file that has a counterpart in the relational database. Designers should fill in all tag values associated with each tagged element.

**PAGE INTENTIONALLY LEFT BLANK**